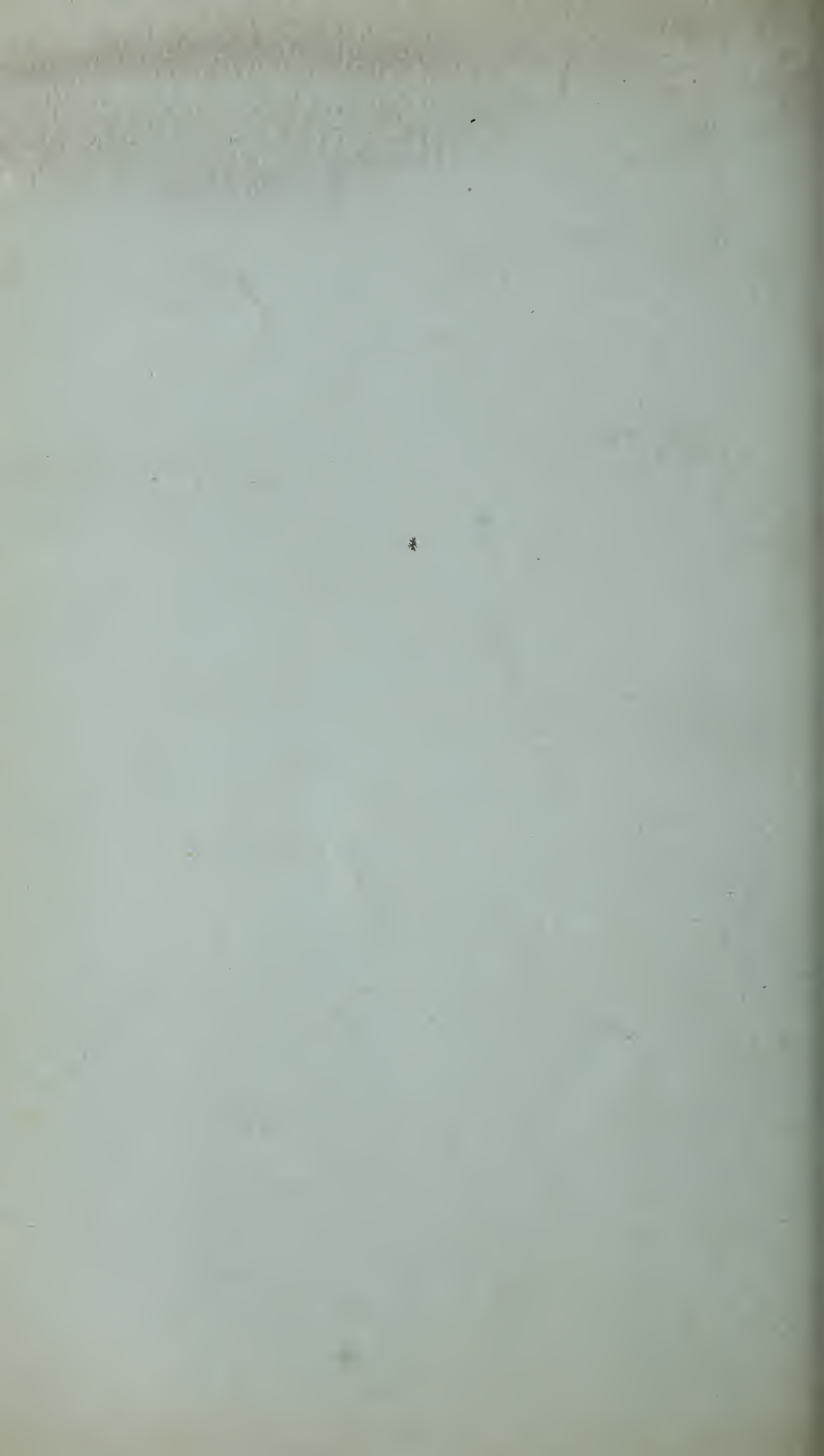


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Issued September 1910.

PORTO RICO AGRICULTURAL EXPERIMENT STATION.

D. W. MAY, Special Agent in Charge.

ANNUAL REPORT
OF THE
PORTO RICO AGRICULTURAL
EXPERIMENT STATION
FOR 1909.

UNDER THE SUPERVISION OF
OFFICE OF EXPERIMENT STATIONS
U. S. DEPARTMENT OF AGRICULTURE.

MAYAGUEZ, P. R.
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(Under the supervision of A. C. TRUE, Director of the Office of Experiment Stations, United States Department of Agriculture.)

WALTER H. EVANS, Chief of Division of Insular Stations, Office of Experiment Stations.

STATION STAFF.

D. W. MAY, *Special Agent in Charge and Animal Husbandman.*

J. W. VAN LEENHOFF, *Coffee Expert.*

W. V. TOWER, *Entomologist.*

P. L. GILE, *Chemist.*

C. F. KINMAN, *Horticulturist.*

OSCAR LOEW, *Physiologist.*

G. L. FAWCETT, *Plant Pathologist.*

E. G. RITZMAN, *Assistant Animal Husbandman.*

W. C. TAYLOR, *Assistant Chemist.*

T. B. MCCLELLAND, *Assistant Horticulturist.*

W. E. HESS, *Expert Gardener.*

CARMELO ALEMAR, JR., *Stenographer.*

LETTER OF TRANSMITTAL.

PORTO RICO AGRICULTURAL EXPERIMENT STATION,

Mayaguez, P. R., June 15, 1910.

SIR: I have the honor to transmit herewith and recommend for publication the Annual Report of the Porto Rico Agricultural Experiment Station for the fiscal year 1909.

Respectfully,

D. W. MAY,
Special Agent in Charge.

DR. A. C. TRUE,

Director, Office of Experiment Stations,

U. S. Department of Agriculture, Washington, D. C.,

Publication recommended.

A. C. TRUE, *Director.*

Publication authorized.

JAMES WILSON.

Secretary of Agriculture

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ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION FOR 1909.

SUMMARY OF INVESTIGATIONS.

By D. W. MAY, *Special Agent in Charge.*

INTRODUCTION.

The year 1909 was the most prosperous in the history of Porto Rico. Crops were generally good and the production far exceeded that of any previous year in the record of the island. Coupled with abundant harvests good prices were realized, due in large part to the free entrance of all products into the great markets of the United States. While some classes of agricultural produce were less profitable than others, still there was advance along the entire line. Some products that find a protected market in the United States were very profitable indeed; others that meet an open market before all the world were not so highly favored as regards prices. This is particularly true of coffee, which comes into direct competition with the enormous crops produced by Brazil and already established in the markets of the United States. Fresh pineapples, which have a small protection, found fierce competition from Cuba, while the canned fruit had to compete with that from the Hawaiian Islands.

Weather conditions were in the main favorable. No disastrous storms visited the island. The long three-year drought of the south side of the island was broken by copious rains, resulting in an enormous production of cane in that section. The coffee crop was the largest for many years and will enable the planters to put their groves into better condition for succeeding crops.

The experiment station has made substantial progress in its work and investigations. The income from Congress for the year was increased by \$2,000, making a total of \$26,000, the same sum appropriated for each state experiment station. Such liberal treatment on the part of Congress has permitted great expansion of the station activities. While the opportunity for work at tropical stations is very large and there are but few individuals engaged therein yet it has been the policy of the station to concentrate its efforts within more definite lines of work. The departments of the station have been separated under definite heads and

the lines of experiment cut down. This has been made possible by increased additions to the staff and the completion of some general lines of work.

Owing to a deadlock in the legislature no appropriation bills were passed at the last session, and additional means asked for by the station were not given. The building for which an appropriation was made in the previous session of the legislature has been finished and is now occupied by the various departments.

This has very greatly increased the facilities of the station and materially added to the effectiveness of the work.

A barn for horses, 40 by 60 feet, and one for sheep, 30 by 40 feet were erected during the year. These are well adapted to their purpose and were constructed largely of cement and covered with tile manufactured on the place. Owing to the ravages of the white ant, cement construction is growing in favor in the Tropics. For roofing, tile are the cheapest considering the length of time they last, and make by far the coolest and most comfortable covering for buildings. Several cement culverts were also built, more cement posts set, fences built, and the general condition of the farm greatly improved.

The various divisions of the station work are agronomy, horticulture, entomology, plant pathology, chemistry, and animal husbandry. Reports from the different divisions are herewith submitted under separate heads.

The work of the office has increased greatly, especially in the line of sending out information. Besides the distribution of bulletins and reports a large correspondence has grown up along the line of agricultural extension. The planters of the island are calling more and more upon the station for information along various lines, and, as it is impossible to visit the plantations as much as desired, a great deal of correspondence is necessary. During the year 2250 letters were sent out from the office, besides many thousand bulletins, reports, circulars, seeds and plants, for the purpose of bringing the investigations of the station before the people and enabling them to obtain the greatest benefit from its efforts. It is hoped that this work will be still further extended under the agricultural college as soon as it is on a working basis. With its cooperation it is hoped to reach every planter on the island.

The agricultural history of Porto Rico is an interesting one. Under Spanish colonization the idea uppermost seemed to be to harvest the natural resources of the colony. More than one million dollars in gold were taken from the island and so thoroughly did the early pioneers do this that at present the industry is extinct. As the cheapest laborer cannot now make a living washing gold some idea may be had of how closely this resource was mined. In a somewhat similar way the fertility of the soils of Porto Rico has been exhausted, so that at present it is necessary to begin work with a soil that has been greatly depleted of its natural fertility. The problem then is not to take a country with its natural resources untouched and continue it in a husbandmanlike manner but rather to take it as if it were an abandoned farm and

restore it by the best means possible to its former fertility, being content in the meantime with such profit as can be legitimately obtained while having in mind a future prosperity. Therefore, in agriculture those bonanzas which have come in utilizing the natural resources cannot be expected but on the contrary it is necessary to be content to first build up the soil at the least cost while looking to the future for greater profits.

SUGAR.

The greatest crop of Porto Rico continues to be sugar. The available lands for the production of sugar cane consist of a belt around the island, mainly of low land. This has been pretty well planted, and in the best watered districts hill planting is extending. The greatly increased output of sugar does not come, however, so much from cultivation of larger areas as from a greater production per acre. This production is brought about by better cultivation, the fertilizing of the soil, and the growing of improved varieties of cane. Better cultivation is followed because the planters are studying the subject, while their profits enable them to more highly fertilize their soils. The work of the experiment station has brought to them the importance of growing better varieties of cane with a higher sucrose content and with less liability to disease. During the year the experiment station has issued a bulletin on sugar cane, which deals with the several phases of the production and harvesting of this crop. The station is continuing work along this line and especially in the breeding of new varieties and the introduction of those from foreign countries. Small amounts of the different varieties are distributed to progressive planters in different sections of Porto Rico for the purpose of establishing cane gardens whereby they may determine the varieties best adapted to their local conditions and for the purpose of encouraging the planting and dissemination of these canes. Some of the better varieties are produced in larger amounts at the experiment station and sold when 8 or 10 months old for seed at the rate of \$5 per ton. These canes are cut up into pieces and the entire stalk planted in order to obtain more quickly marketable amounts of these varieties. The largest sugar company on the island has established two plant breeding stations devoted to the production of new varieties and their dissemination among their colonos.

COFFEE.

The coffee crop of the year has been unusually large. Prices, however, have remained practically stationary and the crop still finds its market in Europe and Cuba. Attempts to introduce Porto Rican coffee into the United States have not resulted favorably. The flavor of the bean does not seem to appeal to the American palate and practically all of the coffee crop still goes to European markets, even though the trade relations are not the best and in some instances very high tariffs are in effect against the

coffee of Porto Rico. Nearly all the coffees sold in the United States are blends and the handlers of this product use as a basis for making these the cheap Brazilian coffees. Porto Rican coffee is relished for its own peculiar merits and does not lend itself to blending with other coffees. It is believed that if the taste is once acquired for it it will hold its own against all others; but regarding its marketing in the United States it must be remembered that it is very difficult to change the taste of a people.

Experiments with coffee have been very much extended during the year. The agricultural college has bought an old coffee farm of 90 acres adjoining the experiment station. This property has been in coffee for many years and was in very bad condition, coming under the classification of "abandonada." This farm has been put in charge of the experiment station and is being used for demonstration purposes, the object being to determine the best methods of bringing run-down coffee properties to a state of productiveness. In doing this it is the general plan to make the estate pay the cost of its improvement. The various lines undertaken under this head are, methods of cultivation, pruning, shading, replanting, and the propagation of varieties of coffees from other countries, especially those that already command the highest prices in the markets of the United States.

The coffee substation in the mountains is still carried on. The report covering the same will be found under its special head. A number of foreign coffees are now in bearing and so far as tested they seem to retain their peculiar flavor and aroma when grown under Porto Rican conditions. Samples have been submitted to various persons and have been very favorably received.

During the year an association of coffee planters has been formed which will doubtless lead to great good in the furtherance of this industry on the island. Not only will better markets be found but such an association can but stimulate the members thereof to better and greater efforts in improving their plantations, a matter much to be desired in this industry in Porto Rico.

TOBACCO.

Tobacco continues as one of the leading exports of the island, not only in the leaf but in the manufactured product. While there has been an increase in the production of tobacco for several years, there has also been a great improvement in the quality of the product. There has been some extension also in the areas devoted to the growing of tobacco, but it is still confined mainly to the interior valleys accessible to the macadamized roads. Several thousand acres of wrapper tobacco are grown under cheese cloth. This industry is mainly in the hands of large companies, while as a rule, filler tobaccos are grown by small planters. One of the large companies has established an experiment station and fitted up a large and complete laboratory for the study of soils, diseases, insects, and fertilizing of tobacco. The experiment station at Mayaguez is not situated in a part of the island where tobacco can be successfully grown, owing to the nature of the soil and its

proximity to the sea, but some cooperative work has been carried on in the tobacco districts.

FRUIT.

Certain matters relating to the fruit industry are discussed under the report of the horticulturist. During the year the production of citrus fruits and pineapples has increased enormously, but the market conditions have been bad. The grower of citrus fruit has found a keen competition with the enormous crops of California, Florida, and Cuba. Pineapple growers have found a close competitor in Cuba with fresh fruits and Hawaii in canned goods. It has been determined that Porto Rico can produce excellent oranges, grapefruits, lemons, and pineapples and the important problem now is to market to the best advantage the fruit so produced. It is especially desired by this industry that better methods of packing be employed, also that the shipping facilities be bettered and the marketing be more closely looked after by persons who will not only obtain the best returns for the growers but will post them as to markets, the condition in which their fruit arrives, and give them advice regarding packing. The horticulturist of the station has spent some weeks in Florida working with the field force of the division of pomology of the U. S. Department of Agriculture, in packing citrus fruits. It is hoped during the next season to have similar work carried on in the groves of Porto Rico.

RICE.

Some progress has been made in rice growing in different sections of the island. Certain soils that have proven to be swampy and not fitted for other crops have been turned into profitable rice fields. Again some fields that have been devoted to cane and which because of continuous planting to this crop have become unprofitable have been changed to rice. It is to be hoped that this industry may be furthered in the future, as rice is the largest import of the island, amounting to over one million dollars annually. Moreover, many of the cane fields, because of continuous planting to one crop, have reached a condition where it is necessary that the owner look for a rotation. Rice will be found profitable on many of these lands and at the same time give the desired change. In going into this industry, however, the grower should consider the fact that machinery must be employed in order to compete with the rice-growing sections of Louisiana and Texas, which now produce practically all the rice that is consumed here. While Porto Rico has at present a fair supply of cheap labor yet it is not possible for labor to compete with the drill and the harvester in the production of grain.

FIBERS.

A number of fibers tested at the experiment station give promise of commercial success. Among these are Sea Island cotton

sisal and ramie. Sea Island cotton can be produced advantageously in many sections of Porto Rico. The industry, however, has made little progress. No insurmountable obstacles are in the way, but being practically a new industry it is very slow in getting a foothold. The cotton caterpillar is the worst insect enemy, but it can be controlled very easily as it is in the southern States. The few attempts to produce cotton on a large scale, however, have come to grief because of this insect, due to the fact that the planter was not prepared to combat it when it came. Nearly all the Sea Island cotton now grown is in small amounts. There is a lack of gins for handling it and also difficulty in marketing it to the best advantage. In many sections of Porto Rico, however, this crop will prove profitable, but it needs to be grown with the best methods of cultivation, proper fertilization of the soil, protection from the caterpillar, and picking and marketing under the best conditions. In other words, it requires more intelligent efforts behind it.

Under an appropriation by the insular government 75 acres of sisal are planted on the south side of the island on dry, stony, government land that is not fitted for any other crop. This planting has been out now for more than a year and has made a splendid growth. As soon as it is mature a machine will be purchased and the fiber extracted. Strict account is kept of the expenses of running this plantation, which are kept at the lowest amount possible, and it is hoped that it may be demonstrated to be a success. Should it turn a profit, there are thousands of acres of land on the south side of Porto Rico which could be devoted to the production of this crop, which now forms one of the great agricultural imports of the United States.

Hat weaving is one of the industries of Porto Rico, and the palm used for that purpose is one native to the island, but it does not produce a fiber comparable to that of the Panama (*Carludovica*.) The latter plant has been imported from Ecuador, and plants are being distributed through the sections where this industry thrives. It has every indication of success.

FORESTRY.

The prosperity of the island depends mainly upon agriculture, and besides increasing the yield of the arable soils, certain others must be brought into production. On many of these unproductive areas this can best and probably only be brought about by planting trees. The idea prevailing in Porto Rico that coffee must be grown under shade has several points in its favor. Practically all Porto Rican fruits require protection from the wind, many of them from the sun. This is best given by larger and stronger trees and since the trees most employed belong to the family of legumes and therefore add nitrogen to the soil the popularity of this practice is readily understood. Many of the lands that have become deforested are almost sterile, producing only a very scanty herbage used for pasture. The yields from these lands are so small that their value has fallen very low. Unless



Fig. 1.—Panama hat palm (*Carludovica palmata*.)

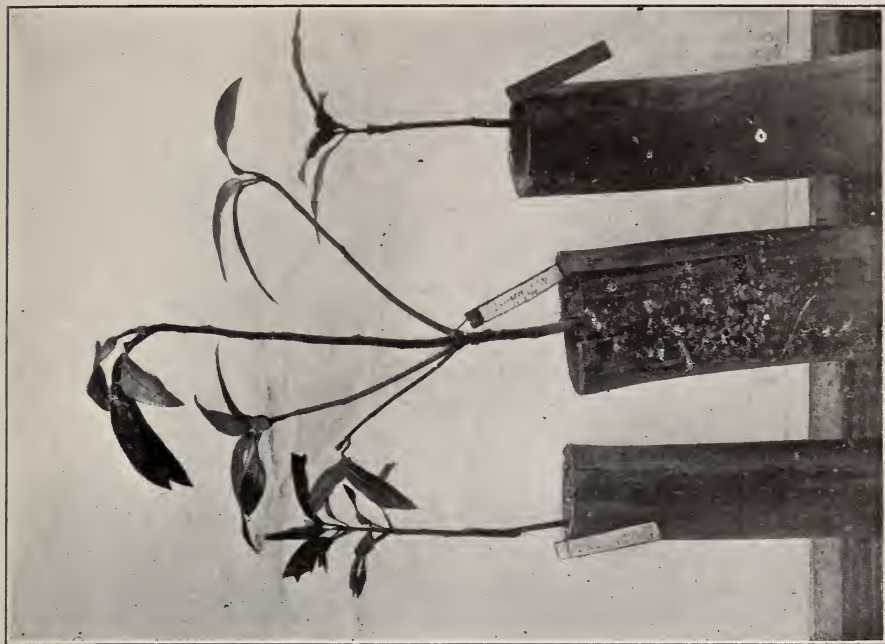


Fig. 2.—Methods of propagating mangoes.



such lands are connected with valleys or forested areas it is almost impossible to sell them. The first consideration in dealing with these large areas is to get them again covered with trees.

On the experiment station certain bare hills which fall within this category are under experiment to determine the best method of bringing them into profitable tree growing. By far the larger number of trees planted have failed to make a satisfactory growth. The land is sterile and the sun soon dries them out. Very few trees will grow unless they are protected by some other tree against the damage from sun and wind. As a rule the trees that will grow on such soils are worthless; however, some have been found which promise success. A few leguminous trees are among this number, including the *Pithecolobium*. Among fruit trees the mango is the only one that promises any degree of success when planted in these areas. Its growth in the beginning, however is slow. The mahogany makes a good growth and in many sections will prove profitable, although the returns will not come in for many years. The eucalyptus among a great number of kinds planted has proved the best and will probably yield a profit earlier than anything else on such soils. The great difficulty in growing this tree, however, is in getting the small plant started. The station has not yet been able to produce its own seed although the first planting of 4-year old trees are 40 feet high. From recent experiments, however, it is hoped to propagate this tree by cuttings and, if the experiments prove commercially successful there is no reason why the area devoted to this tree cannot be greatly extended in a few years.

LIVE STOCK.

The breeding and dissemination of improved live stock, as described in previous reports, has been continued with an increase of interest on the part of the plantation owners. This work includes Thoroughbred and saddlebred horses, Shorthorn, Hereford, Holstein, Jersey and Zebu cattle, Berkshire pigs, African woolless sheep, geese, ducks, and Plymouth Rock and Leghorn chickens. A definite report on these is to be found under another heading. The demand for live stock has grown so in Porto Rico that whereas a few years ago the exportations were large now not only work animals but meats are being imported. With the increasing plantings of the land less and less will be devoted to live-stock. On the other hand, the quality of the animals is being improved and they have increased enormously in value. Dressed meats are brought from the United States and the prices are very high. Formerly large numbers of cattle were brought from the Spanish Main, Venezuela, but owing to the quarantine laws of the island such importations are now wholly excluded.

SEED AND PLANT INTRODUCTION.

The work of introducing and propagating foreign plants that may become of commercial importance to Porto Rico has greatly

increased during the year. An assistant horticulturist and an expert gardener have been added to the staff, the latter devoting his time almost exclusively to this work while the former relieves the horticulturist of some of his duties, which have become quite extensive. Work in plant introduction is devoted mainly to those that may add to the wealth of the island, although some regard has been given to the propagation of ornamentals. Several thousand packages of seeds and plants have been sent out by mail and express to all sections of the island, and many of the introductions that have proven a success are now becoming a factor in the commercial development of the island.

COOPERATION

Cooperative work is still under way with various planters in the introduction of new varieties of economic plants, fertilizer tests of various soils, shipping experiments, testing the influence of fertilizers on the keeping quality of fruits; with the insular government in testing fibers; with the agricultural college in the demonstration work of a coffee plantation; and with the various bureaus of the U. S. Department of Agriculture in various lines of work.

REPORT OF THE PHYSIOLOGIST

BY OSCAR LOEW.

The chief object of the work this year was to collect as much information as possible on "sick" or "tired" soils of Porto Rico and to carry on various disinfection experiments on such soils. A circular (a) was prepared treating of the present state of knowledge on tired soils and the effects of soil disinfection on the productivity of the soil. A further circular is in course of preparation giving the results of investigations of certain tired soils of Porto Rico.

At the Aurelia coffee plantation some very striking phenomena were observed in regard to the gradual dying of coffee trees in a certain section. Since parasites were absent and the soil was still far from being exhausted and manuring did not improve the condition, disinfection experiments were carried out, but results as to the development of the newly planted trees can only be expected after the roots have reached a certain depth. Sick coffee trees were observed at the plantations of Rosita and college farm.

A trip was made to a pineapple plantation of Isla Verde near San Juan and the soil examined, and the extensive tobacco fields of the American Tobacco Co. near Cayey and Caguas were visited and the soil bacteriologically examined.

An excursion from Arecibo to the cane plantation of Los Caños, the tobacco fields of Utuado, and the plantations near Ponce proved very instructive in several ways. Several miles east of Ponce the flat lowlands are partly covered by salt efflorescences containing sodium sulphate and similar salts. Whenever enough water is available to leach out these salts, there will be a considerable gain of valuable land.

Additional information was collected at the cane plantations near Hormigueros and Las Dolores. Not only had the yield decreased at the latter place but the young plants had slowly died. The disinfection experiments carried out on these plantations will show results later on. In all the cases of tired soils a great excess of the butyric microbe was observed in the soil.

Among the disinfectants experimented with tricresol was tried in order to gain some information as to its affecting plants especially the root growth, laboratory experiments having shown that this compound was injurious at a dilution of 0.01 per cent but not at 0.001 per cent in water cultures. It was found that plants growing in soil watered with 0.01 per cent solution were apparently not injured. The absorptive power of the soil probably depressed the poisonous qualities of the compound. In practice it will be found preferable to disinfect the soil four weeks before planting in order to give time for the disinfectant to be oxidized or volatilized.

(a) Porto Rico Sta. Circ. 11.

Among the disinfectants especially recommended during the last two years is carbolineum, a product of coal tar distillation, which acts partially by virtue of its hydrocarbons but still more by its phenol content, especially the creosol. (a)

As to the bacteriological examination of soils it is necessary above all to distinguish between aerobic and anaerobic microbes. The aerobic organisms are to a great extent only oxidizers of organic matter, whereby the nitrogen of this organic matter is liberated as ammonia, which may or may not be transformed into nitrates before it is absorbed by the roots. Of the aerobic bacteria usually found in soils *Bacillus mycoides*, *B. subtilis*, *B. fluorescens liquefaciens* and *Proteus vulgaris* were easily identified, *Bacillus anthracoides* was found in one case.

In the soils of the college farm and at Aurelia there was found a great preponderance of *B. mycoides*, while *B. fluorescens liquefaciens* (b) was rather rare. In general the inference can be drawn that there is no essential difference between healthy and sick soils in regard to the number of aerobic bacteria they contain, but there certainly is an essential difference in regard to the number of anaerobic microbes.

It was also found necessary to distinguish between facultatively anaerobic and absolutely anaerobic microbes. The investigations, mentioned above, have established the presence of a great excess of the butyric bacillus in the sick soils. Several kinds of this bacillus exist and among them obligate anaerobic and facultatively anaerobic varieties have been observed. The varieties thus far observed in Porto Rican soils appear to belong to the latter group, since there was never any difficulty encountered in cultivating them in the presence of air. (c)

A rich infusorial life was sometimes observed in soils, especially in those that were sandy. This low animal life no doubt plays a much more important role in the soil than is recognized at present. The nitrogen content of soil is doubtless partly due to the encysted and active infusoria, which feed extensively on microbes, as can be readily seen under the microscope. Soil nitrogen in the form of microbes and infusoria is of course unavailable to the roots until bacterial enzymes dissolve them. Hence, even a comparatively high content of nitrogen in the soil may be of little immediate value. (d) One soil of Porto Rico was found to contain as much as 0.63 per cent of nitrogen. Of eighteen soil samples the nitrogen content was over 0.2 per cent in four cases and the average

(a) Under the name of carbolineum occurs also in commerce an emulsion of antiseptic products in soap solution; the genuine product contains no soap.

(b) This microbe is said to be a weak denitrifier.

(c) The butyric ferment exists also to a large extent in certain soils of Kamerun which the writer recently had occasion to examine.

(d) There occur in soils, however, nitrogenous compounds produced by microbes which seem to be of little value, as, e. g., the picolin carbonic acid discovered in humus soils by Shorey. It may be mentioned in this connection that nitrogenous compounds have been found by Dyer in a clay of Kent at a depth of 1370 feet. This clay contained 0.786 per cent carbon and 0.0483 per cent nitrogen. [Cf. U. S. Dept. Agr., Office of Expt. Sta. Bul. 106, p. 59.]

was 0.16 per cent. How much of this nitrogen is a constituent of humus produced by decay of roots, leaves, and other organic matter, and how much is due to living and dead microbes is not an easy matter to decide accurately. A certain approximation might be reached, however, when it is taken into consideration that nitrogen may amount to from 1 to 6 per cent in the humus matter; in peat, which represents a state of humus, the nitrogen content of the organic matter is generally below 2 per cent and probably never exceeds 3.4 per cent. This leads to the inference that in Porto Rico the nitrogen found in soils is, after subtraction of the small amounts due to ammonia or nitrates, chiefly due to microbes, mold fungi, and infusoria, living or dead, (a) because the humus content is in most cases a mere trifle, (b) exceeding the nitrogen content but little and sometimes being even lower than the nitrogen content of the soil. (c)

It would be of value to have a simple method to determine for comparison the mass of living bacteria by their activity. Since the determinations of the degree of decomposition of hydrogen peroxid by a given amount of soil gives only approximate figures, the contents of iron and manganese and other conditions interfering with the result, soils were compared in regard to the production of carbonic acid by the microbes present.

In the determinations 5 gm. soil were moistened and kept for two days in a flask through which purified air was occasionally drawn. The carbonic acid produced was absorbed by titrated barryta water. Carbonic acid was found as follows:

In Aurelia healthy soil	.0003 gm,	corresponding to	.06 gm. per kilo.
In Aurelia sick soil	.0007 gm,	„	.14 gm. „ „

These figures approach those found in similar determinations by Stoklasa with soils of wheat fields. It may be objected that these figures will vary according to the amount of organic compounds available to the microbes for their respiratory or fermentative activity, and that temperature and moisture content will also influence the result. However, the method might be perfected to such a degree that figures for satisfactory comparison might be reached.

Since the butyric bacillus develops rapidly in soils where roots containing sugar or starch are decaying, and since by its fermentative activity acids are produced, it might be supposed that liming the soils would prove beneficial as the acids would be neutralized and the neutral salts thus formed would easily be completely

(a) The more nitrogen present in ratio to the humus, the more alkaline will be the vapors produced by heating soil in a test tube. When the true humus matter, however, predominates over the bacterial mass in a soil, then the reaction of the vapors produced by heating will be acid. Some soils of Porto Rico produced on heating strong alkaline vapors.

(b) Humus formation in the Tropics seems to be favored only when the ground is covered continuously with water. [Peats occur in Sumatra and Damerara.] On a dry land the intense red color of many soils in tropical lands betrays the deficiency of humus. Red soils predominate in Hawaii and in the Philippines.

(c) The humus content was determined by the chemist of the station after the official method.

oxidized by the mold fungi present. An experiment was suggested on the sick soil of the Aurelia coffee plantation with lime alone and with a mixture of slaked lime with gypsum. (a)

Some attention was paid to the subject of liming of cane soils. It has been shown in a former report that a certain ratio of lime to magnesia is required for the most favorable development of plants. A special circular (b) was prepared in the summer of 1909 to give further explanations and an account of various experiments made in this direction. It is very probable that the best ratio for cane will approach that for maize viz, 2 lime: 1 magnesia. An excess of lime beyond this proportion, however, will prove less injurious than an excess of magnesia. The cane soils of Hawaii contain, as an average of 50 analyses, nearly equal amounts of lime and magnesia, according to a communication of W. P. Kelley, chemist of the Hawaii Experiment Station. In the cane soils of Demerara the ratios are: lime from 0.1 to 0.6 per cent, magnesia from 0.3 to 0.5 per cent.

The observation of Hilgard that in tropical regions the magnesia content exceeds the lime content with unusual frequency was found true also for Porto Rico. (c) Mr. Kelley also declared: "The soils of Hawaii other than sugar cane soils vary between wide limits as to the content of lime and magnesia, but it is not at all uncommon to find two to three times as much magnesia as lime." Hence, liming becomes a most important operation in the Tropics.

Experiments were begun to test the so called humus-silica, a preparation of Gerdez, which it is claimed has exerted a very beneficial effect on certain soils in Germany. It may be that in this preparation the silica, derived from soluble glass is retained in an easily soluble condition and that in this form it may be readily absorbed, forming then a protection against fungi, (d) or exercising some stimulating effect. Much investigation is still required in this matter and the station has undertaken a series of experiments on these lines. Many investigations in this line have been made at Rothamsted, (e) and the conclusions reached on the influence of silica on the growth are the following. "The effect of a free supply of soluble silica manifests itself in an increased and earlier formation of grain, and is thus similar to the effect of phosphoric acid. The silica acts by causing an increased assimilation of phosphoric acid by the plant, to which phosphoric acid the observed effects are due."

(a) Gypsum must be applied with care to such soils as contain the sulphate reducing microbes in great number, since hydrogen sulphide might be produced, which is poisonous for roots.

(b) Porto Rico Sta. Circ. 10.

(c) Cf. Notes on the Soils of Porto Rico, Porto Rico Sta. Rpt. 1908.

(d) Trees have sometimes so much silica that it becomes difficult for parasitic fungi to penetrate the bark.

(e) On the Function of Silica in the Nutrition of Cereals, I. Proc. Roy. Soc. (London, Ser. B, 77 (1906) No. B) 520, p. 455.

REPORT OF THE HORTICULTURIST.

BY C. F. KINMAN.

Over 50 varieties of oranges are now growing in the station orchards, including many of the best known commercial varieties. Thirty of these are fruiting this season, and notes in regard to productiveness, quality of fruit, and other points, are being recorded as fast as they ripen. The varieties that are fruiting were set out from three to five years ago. Though they were set in a very heavy, poorly drained clay soil, many of them are giving very satisfactory results. Those that are doing best are Thompson Navel, Homasassa, Parson Brown, Centennial, and Pineapple. The trees of Washington Navel are making a satisfactory growth, but so far the fruit has been of a very inferior quality. A number of selected native seedlings are fruiting this year. These trees have made a good growth but are slow in coming into bearing. As some of these selections have produced excellent fruit and give promise of being of value commercially, they will be tested further and distributed to planters.

Of the sixteen varieties of pomelos that are growing on the station grounds only six were old enough to bear fruit this season. Those that are fruiting are growing in the same type of soil as the oranges mentioned above. The texture and flavor of this fruit is very good and although the fruits have rather thick rinds and are not perfect in shape, grapefruit culture even on this soil is very promising. The Duncan, Marsh Seedless, and Pernambuco varieties gave the most satisfactory results this year. The trees of the Tresca and Bankok seedless varieties have made excellent growth and have borne well; the fruit, however, is so poor in quality that the trees will be removed.

Of the thirteen varieties of lemons growing in the orchard eight have fruited this season. All varieties tested have proved to be very thrifty growers and those old enough to fruit are very prolific. Curing and keeping tests are being made with fruits of different varieties, and experiments are under way to determine the best methods for pruning. The trees of Rangpur lime, Marumi kumquat, and Oneco mandarin set in December, 1904, are bearing a good crop of excellent fruit. The Rangpur lime is very prolific, bearing over 400 fruits per tree.

As the citrus trees come into bearing many of them are found to be not true to label, which makes it necessary to re-map and relabel the orchards.

In this climate where the soil is washed so badly by heavy rains and where on account of wet soil cultivation is for a part of the year impossible, the need of cover crops becomes more and more apparent. A few native legumes are being collected and these with other leguminous crops will be tested in the station

orchards and by cooperating with planters in other types of soils where citrus fruits are being grown.

The stocks for citrus fruits in Porto Rico have as yet not been thoroughly investigated, though the rough lemon seems to be most popular at present. On account of the numerous soil types and the varying climatic conditions the question of stocks is an important one for citrus growers in Porto Rico. Seed of native sour and sweet orange, native rough lemon, pomelo and *Citrus trifoliata* have been collected and planted and will be used in an experiment to determine the best stocks for oranges, pomeles, and lemons in at least three types of soil.

The fertilizer experiments in citrus groves that this department has been carrying on in cooperation with planters since 1906 are being continued this year in three of the four orchards. A large amount of data has been collected in this work and it is hoped that at the end of another season definite conclusions will be reached.

In order to investigate orchard management as it is practised in Porto Rico and to place on permanent record the state of the fruit industry while still new on the island, it has been decided to make a general orchard survey. It is the plan to visit personally each grower and to collect all data possible as to the influence of soils, drainage, fertilizer, growth of varieties and similar questions, and to report the results when the work has been finished. From these investigations it is hoped to answer definitely many of the troublesome questions that come up to growers and others interested in the industry. This work has been begun and will be carried on as fast as possible.

TEMPERATE CLIMATE FRUITS.

Most of the peach trees set out in the spring of 1905 are still living. The Red Ceylon has made better growth than any of the other varieties. This variety blossomed heavily in the early part of December and is bearing a good crop of fruit. The Peento variety has grown fairly well though not so well as the Red Ceylon, while the other varieties have made a very poor growth. The peach trees in the station orchard were set in a heavy, poorly drained clay soil and do not, of course, develop as they would in a better soil. However, it does not seem that they have any commercial value in Porto Rico excepting possibly the Red Ceylon and Peento varieties.

The LeConte and Kieffer varieties of pears set out in the spring of 1905 are making slow growth, the Le Conte being about 8 feet and the Kieffer 5 feet tall. The LeConte blossomed in November and is bearing a few fruits.

The Early Harvest and Red Astrachan varieties of apples set at the same time as the pears have made about the same growth as the latter. One tree of Early Harvest is 2 inches in diameter at the base and 6 feet tall while the other trees are somewhat smaller.

None of the varieties of plums set out in 1905 have made a

satisfactory growth. The Abundance, Red June, and Burbank, have made the best growth, reaching at present 6 feet in height. The Burbank trees have a few excellent fruit this season. The variety Terrell has made a very slow spreading growth and the Excelsior is dead.

The six varieties of Japanese persimmons set out in March, 1905, are living though making but little progress. The trees average from 1 to 2 inches in diameter at the base and from 2 to 4 feet in height. So far these trees have not borne.

While the apple, pear, plum, and persimmon trees in the station orchard have made some growth, it seems improbable that they will have any commercial value in this locality.

MANGOES.

The mango planting in the station orchards includes at present 46 varieties. The varieties Sandersshah, Ameeri, and Cambodiana bore fruit this year. Trees of improved varieties set out in 1904 are now 18 to 20 feet tall and have a spread of from 12 to 15 feet. From this it seems that these trees will prove to be an excellent wind-break for our citrus orchards. Over 150 inarches have been made from seedlings raised from the crop of 1909. These are being used to increase the station plantings and for distribution.

AVOCADOS.

The avocados in the station orchard have given very little satisfaction. The young trees grow fairly well for some time after setting, but when they reach the height of from 12 to 18 feet the inner leaves and branches begin to die as if from starvation, and within a year or two the entire tree is dead. This trouble is probably due to the unfavorable soil condition, the soil being a very poorly drained clay. Fertilizer and cultural tests are being tried for remedies for this trouble.

MISCELLANEOUS PLANTS.

A large percentage of the varieties of bananas in the station plantation has proved to be worthless commercially, and but few give much promise. The better varieties were removed from the heavy, poorly drained soils to a more suitable location. A few types that have given good results in portions of the island but at present not in the station collection will be tested with the other varieties.

The fertilizer experiment with coconuts started a year ago is being continued. But few of these trees, set out a year ago, have died. At the end of the first year no result as to the effect of the fertilizers could be noted.

In the station orchard of miscellaneous fruits, which is situated on a gradually sloping heavy clay hillside, the following have produced fruit during the past year: Otaheite gooseberry (*Phyllan-*

thus *disticha*), Otaheite apple (*Eugenia malaccensis*) akee (*Blighia sapida*), voa vanga (*Vangueria edulis*), candlenut (*Aleurites moluccana*), loquat (*Eriobotrya japonica*), jack fruit (*Artocarpus integrifolia*), Surinam cherry (*Eugenia uniflora*), myrobalan (*Phyllanthus emblica*), egg fruit or Ti-es (*Lucuma rivicoa*). Among these the Otaheite apple, loquat and jack fruit prove to be excellent for ornamental trees as well as for their production of fruit. The jack fruits, planted November, 1903, while bearing but a very few fruits have made a splendid growth, averaging at present 20 feet in height and with a spread of 20 feet. The loquat trees are 10 feet in height and have a spread of 10 feet. The Otaheite apple trees are 18 feet tall and with a spread of 12 to 14 feet.

To the coffee of the station farm more than a thousand trees have been added during the year, including the following varieties: Columnaris, Erecta, Guadeloupe, Pantgoer, Padang, Preanger, Maragogype, Mocha, Java Mocha and Mocha hybrid. An experiment is being carried on to find the best method of transplanting coffee in respect to size of trees, roots incased in surrounding clod or root system bare, if root system bare, roots clipped or unclipped, and whether young trees at trasplanting should be clipped six inches above surface or set out without cutting back. Various methods of pruning and heading back are being tried. A coooperative experiment has been started in working over an old coffee plantation by means of which it is hoped the old, poor, and straggling trees may be worked over into new healthy ones without the loss of more than a partial crop. As the period of vitality of coffee seeds is known to be short, a test is being made to show how long they may safely be kept under ordinary local conditions and how long where all moisture is excluded. Every two weeks a planting is made of seed kept in a cotton sack exposed to the open air, and another planting of seed from a closed jar containing calcium chlorid.

A number of plantings of *Theobroma cacao* have been made, including the following varieties: Red Calabacillo, Criollo Calabacillo, Criollo Red and Yellow, Forastero, Cundeamor, Lapp Forastero, Brown Ceylon, and cacao from Guadeloupe. A planting has also been made of *Theobroma pentagona*. Notes are being kept as to quantity and quality of beans of the various cacaos bearing on the station farm.

EUCALYPTUS.

At present 20 species of Eucalyptus are growing on the station grounds, new plantings of nearly all of these species having been made during the past year. Of 14 kinds that were set cut 14 months ago in low wet lands, the trees of *E. robusta*, *E. pipeita*, *E. rostrata* and *E. tereticornis* are making the most rapid growth. Some of these trees are at present 16 feet tall. These kinds will be used in making plantings in low, wet, and at present waste lands. Plantings made last February were, on account of the severe drought at that time, unsuccessfull, while plants set cut in the

opening of the rainy season or a few weeks before its close have done well.

VEGETABLES.

The experiments with vegetables include tests with seed, viability of imported and home-grown seed; methods for keeping seed in the Tropics; the degenerating influence of the climate on a few garden crops; crossing the hardy native tomato and muskmelon with improved imported types; a fertilizer experiment with tomatoes, and a fertilizer and cultural experiment with yams.

A great hindrance to the present year's work has been the inability to procure seed that would germinate. This with the unfavorable weather conditions, the excessive rains that continued until late in the fall, and the drought during the early winter, has caused the progress of the vegetable work to be very unsatisfactory.

INTRODUCTIONS.

During the past half year over twenty species of horticultural interest, previously not grown at the station, have been received. Many of these have been sent by the Bureau of Plant Industry of the U. S. Department of Agriculture. A piece of land has been set aside for these and the large number of importations received during previous years, and they are being given special attention. Cuttings of a number of species of vanilla have been lately received from the subtropical laboratory and garden of the Department of Agriculture situated at Miami, Florida, and will be tested here.

The distribution of plants and seeds of worthy introductions has been continued. Among the plants and seeds that are being requested by Porto Rican planters, the improved varieties of mangoes and citrus fruits are most in demand. This work of distributing promising plants is being carried on as fast as possible. As the plants distributed by the department go to many localities varying in climate and soil types, it is hoped that data may be collected whereby more definite conclusions regarding the culture and value of these plants may be reached.

PROPAGATION.

Considerable time has been given to the study of methods for propagating Porto Rican tropical fruits. Whip grafting young mango seedlings and grafting the *Anona cherimolia* on a native stock have given promising results. Trials in growing *Aberia caffra*, *Carrisa arduina* and *Couroupita guianensis* from cuttings gave good results.

REPORT OF THE ENTOMOLOGIST.

BY W. V. TOWER.

INTRODUCTION.

The entomological work for the past year has been devoted mainly to studies on the various scale insects which infest citrus fruits. Many of the growers are planting wind-breaks and with new methods of spraying their fruits are making a better showing.

Among the new work that is being taken up in connection with the citrus scale insects is the fumigation of the orange and grapefruit trees. This treatment has been successfully practised in California and Florida and it seems very probable that this method of combating the scale can be introduced with advantage into Porto Rico.

Preliminary experiments are being carried on at the station with sulphur sprays in combating the work of the rust mite, which is causing a great deal of the rusty fruit in the groves. Also much time has been spent in studying the causes of the various scars on the orange and grapefruit.

A bulletin has been prepared on the insects injurious to the citrus group. (a) Therefore, very little will be devoted to the subject in this report.

THE CONTROL OF SOME ORANGE PESTS.

The purple scale (*Lepidosaphes beckii*) is the most serious orange pest in Porto Rico. Much of the fruit so infested has to be washed, and in washing the oil cells are broken, thus making openings for the entrance of fungi. The work of the fungus breaks down the fruit, causing it to decay in transit. This can be greatly remedied by thorough spraying when the fruit is half grown, or by cleaning the trees previous to blossoming. For half grown fruit weak emulsions will have to be resorted to and the number of applications increased to from two to five. The scale, however, can be controlled if sufficient care is given and conscientious work is done.

Many of the planters are using prepared miscible oils. Great care should be exercised in the use of these preparations as they sometimes produce emulsions that contain free oil which marks the fruit. Generally this can be avoided if the stock emulsion is first tested by trying a little of it in water to see if it emulsifies. The mistake made by many is that they do not sufficiently shake the stock solution and when they draw off their first emulsion



Fig. 1.—Sick coffee due to soil conditions.



Fig. 2.—Coffee planted on terraced hillsides.

they obtain only the lighter oils which do not mix properly. Very little trouble is experienced if stock is thoroughly shaken.

Crude-oil emulsion has been condemned by some because the results have not been uniform. This is due partly to the fact that not enough care is taken in making the stock and then in testing it to see if any free oil appears.

An increase is observed of groves that are producing some rusty fruit. The rust is caused by a small sucking insect which punctures the fruit when it is about the size of a walnut, removes the oil from the cells, and renders the surface of the fruit dark. Sometimes this rust is caused by scale puncturing the fruit after which some fungus enters the openings.

The rust mite is easily controlled by any of the sulphur sprays, and during the past season much time has been spent in testing the various formulas. The most promising results have been obtained from the boiled and self-boiled lime and sulphur sprays. The self-boiled sprays are much easier made as they only require boiling water to slake the lime, while the boiled sprays require from 40 to 60 minutes boiling. The adhesive qualities of the self-boiled are not as good as those of the boiled and the former should not be used during periods when there is considerable rain. The insecticidal value of the self-boiled lime and sulphur sprays is not equal to those of the boiled sprays in killing the crawling young of the purple scale.

Weak sulphur sprays sufficiently strong to kill the rust mite can be applied to the trees during bloom without injury.

Dust sprays made with sulphur and air-slaked lime, equal parts, are effective; the lime is added to make the sulphur adhere more readily to the surface of the leaves. One disadvantage of the dry sulphur and lime spray is that it must be applied in the early morning while the dew is still on the trees. In large groves this is difficult to do because the dew remains on the foliage for such a short time.

CANE INJURY.

The larva of one of the *Lachnosterna* beetles is causing a great deal of damage to the roots of sugar cane; in many instances the tonnage of certain areas has been decreased by its destructive work. At the station pot experiments with repellents and chemical fertilizers have been carried on with the adult beetles. The field work is being taken up in cooperation with cane growers. In the pot experiments and field work lime has shown the best results of any of the repellents used, while kainit shows equally good results as a killing agent for the grub in the soil. The experiments are being conducted in duplicate so that the tonnage results may be obtained from one set of plats, while on the other set the stools are examined and notes taken to ascertain the number of insects dead and alive. The limed stools examined after flight contained very few young grubs, thus showing that the female beetles did not care to deposit their eggs in soils containing lime, while in the stools treated with chemicals young grubs were

found in great numbers. During the first season lime did not show any killing power, and live adult grubs were found, while in the stools treated with the chemicals the adult grubs had disappeared, but as the season advanced and the chemicals lost their killing power the young grubs began to appear.

In the pot experiments it was observed that the beetles preferred to lay their eggs in moist soil, as the eggs are liable to be destroyed by the lack of moisture. Experiments with carbon bisulphid are being conducted against the grub. For this work an automatic injector is being used.

During the coming season a number of repellent experiments are to be carried on as soon as the flight of beetles commences. The life history of this insect is under investigation and it seems very probable that it covers a period of one year.

TOBACCO BEETLES.

A beetle borer has been found in a number of the tobacco warehouses, which is doing a great deal of damage to the stored leaf, especially that which has been put up in bales. The new tobacco generally becomes infested by insects in the old bales left from the previous season. Upon opening the bales the work of the borer can readily be seen, but often a great deal of damage is done before the owner is aware that his tobacco has been infested. Valuable wrapper tobacco is made worthless in a very short time by the holes cut in the leaf. A number of experiments were conducted against these insects and very satisfactory results were obtained. During 1908 an entire warehouse was fumigated with potassium cyanid, but this year all the tobacco was put into one room, which proved simpler. In order that the gas should reach all sides of the bales they were arranged in tiers four or five bales high. Pieces of 2 by 4 timber were placed under the first tier of bales to raise them from the floor. They were then spaced, leaving at least two inches between each. After the first tier was arranged 2 by 4 timbers were placed between them and the next tier, and so on until all the bales were in place. The distance between each row was eighteen inches; this left sufficient space for the handling of the tobacco and also air spaces for the gas. This space, however, could be lessened and more tobacco fumigated at once without any extra expense and with a saving of time and cyanid.

If a small room is used the pot containing the potassium may be placed in the center of the room and the bales around it. In this case something should be placed around the pot to prevent the chemicals spattering on the bales and burning the burlap.

The usual methods of fumigating were followed, using 2 oz. potassium cyanid per 100 cubic feet. The relative proportions of the different substances used was as follows:

- 1 oz. by weight of potassium cyanid 98 per cent.
- 1 oz. by volume of sulphuric acid 66 Beaumé.
- 3 oz. by volume of water.

All doors, windows, and cracks, should be packed with bagging. Place the water in an earthenware pot and the potassium cyanid in a bag suspended from the ceiling by a string directly over it. The string holding the cyanid should pass along the ceiling and down through the key hole of the door or through a hole bored in the wall. When all is ready pour the sulphuric acid carefully into the water and pass out of the room shutting the door securely. Then let the cyanid down gently into the pot by means of the string and allow the fumigation to go on for twenty-four hours or longer.

Great caution should be taken in handling the sulphuric acid and cyanid, as the acid burns clothing or anything it touches and the cyanid kills instantly if inhaled or allowed to enter a cut in the hands or any part of the body. It is advisable to handle the cyanid with rubber gloves or forceps. In fumigating a building a man should be placed outside to guard it and great care should be taken in opening up and ventilating it.

The tobacco in Porto Rico and in Cuba is baled in two ways, either in burlap or in yagua, the flattened sheathing base or petiole of the royal palm leaf. Bales covered with burlap were fumigated with very satisfactory results without being opened. However, to fumigate bales wrapped in yaguas with success it is necessary to open them as the gas can not penetrate this material.

BEES.

The work in bee culture has been continued during the past year, and a great deal of interest has been shown and a number of new apiaries started in the coffee districts. At the present time everything points to an increase of this industry. Nuclei have been raised and sold to those who wish to start in this line of work.

No bee diseases have been found on the island and beekeepers should take special precautions in purchasing bees from countries where diseases exist. It seems advisable for those who wish to keep their strains of bees pure to purchase queens, having them sent to the island by mail, rather than to buy nuclei, thus avoiding as much as possible the introduction of disease. Bees in the Tropics work all the year, thus it is necessary to introduce new queens more often than in cooler countries where they have a period of rest during the winter months.

Honey flows are not as long as those in northern countries, but there are a number of good seasons of bloom which produce an abundance of highly flavored honey.

Box honey has been produced in Porto Rico, and the sections were well filled and the honey very white.

MISCELLANEOUS NOTES.

Shipments of parasitized eggs of the tobacco horn worm were sent weekly to the Bureau of Entomology, U. S. Department of Agriculture. This parasite, *Telenomus monilicornis*, has been observ-

ed for a number of seasons in the tobacco fields and a great number of the parasites have been bred at various times and distributed.

A number of experiments have been conducted on a small beetle, *Xyleborus* sp., which destroys the guava and guamá, two leguminous trees which are used as shade for coffee.

The question of wind-breaks is still under consideration and various trees are being tried. Among the more promising are the mango and the bamboo. The last mentioned is especially adapted for this purpose as it is quick growing.

The life history of a small leaf eating beetle is being studied. This insect feeds upon the young tender leaves of the orange and grapefruit. It seems to be especially fond of the the former. Notes on the time of appearance, number of eggs laid by individuals, where laid, number per cluster, appearance of larva and where found, and their habits, have been worked out.

A coffee leaf-weevil, *Lachnopus* sp., is under observation and its life history is being worked out. The eggs are laid in clusters between two coffee leaves and upon hatching the larva pass to the ground.

REPORT OF THE CHEMIST.

By P. L. GILE.

INTRODUCTION.

During the past year the chemical laboratory was transferred from its former quarters in the old sugar house to the new office building, where it occupies a large room for general analyses, a small room for nitrogen determinations, a sample and balance room, and a store room in the basement. Unfortunately the chemical work has been greatly interfered with the past year by disturbances incident to the change. The contractor's delay in installing the plumbing and a subsequent failure of the water supply have made it impossible to accomplish certain necessary work since the middle of the year.

Some new apparatus has been added to the laboratory, a good polariscope, a muffle oven, a small sugar mill for preparing sugar cane samples, and a heavy balance. While there is need for more apparatus the laboratory is now fairly equipped.

The outlook for the coming year is encouraging, as the laboratory is in working order and some of the problems already under investigation have reached a stage where there is a good prospect of their completion. The station has also been fortunate in securing the services of William C. Taylor, as assistant chemist.

A certain number of miscellaneous analyses have been made. Bat guanos, limestones, fertilizers, soils, and water have been analyzed where the results gave promise of affording more than private benefit. Many soils sent to the station have been examined in a general way and advice given when possible. Very little work has been done for other departments, but the coming year there will be several hundred varieties to be tested in connection with the seedling cane investigations.

Aside from work of the above routine character the greater part of time has been devoted to the study of soils and plant nutrition. Many immediately practical problems are to be dealt with, which are being worked on at the station, such as the liming of acid soils, the treatment of alkaline spots, the loosening of very stiff clays, and similar problems. There is a remarkable variety of soils on the island; silicious sands, corallaceous sand, with gradations between these and the stiff red and black clays, also laterite and calciferous soils with varying fertilizer requirements. Since the station soil is of one type only, stiff red clay, some of the problems can only be worked out cooperatively. While some co-operative experiments are already in progress it is very desirable to increase them if definite and reliable results are to be secured. Although the soils are being studied it should be borne in mind that certain points such as the fertilizer requirements can only be settled by experiments upon each particular soil, and that advice given on this subject can only be general at the best.

The field experiments on liming for sugar cane and on the action of carbon bisulphid are being continued.

SOIL DISINFECTION.

One of the chief problems under investigation is that of soil disinfection. This should be particularly important in the Tropics because of the continued warmth and moisture and of the practice of planting the same crop year after year, both of which circumstances favor the undue development of certain species of bacteria.

Disinfection is being tried on certain cane lands which now produce only about eight tons to the acre in spite of thorough cultivation, chemical fertilization, liming, and fallowing. While in many cases the cane shows no disease its growth ceases when a few feet high. The disinfectants employed may have another action in the soil besides the effect on the bacteria. It is impossible to make any definite statements for the work thus far. Carbon bisulphid is used as a soil disinfectant in Europe for certain intensive cultures, but its cost in Porto Rico prohibits its use for commercial crops. Hence, along with experiments with carbon bisulphid, creolin, cresol, tricresol and cheaper germicides are being tried at the station and in cooperation with planters in the vicinity.

In this connection an attempt is being made to discover the cause of the phenomenon often observed, i. e., that plant growth is more luxuriant on spots where charcoal has been burned. That this increased growth is not due to the improvement in the mechanical condition of the soil nor to the fertilizing effect of the wood ashes has already been observed. To study the matter, plats which have already been subjected to burning are being compared with disinfected ones. The practical bearing of the question lies in obtaining a better knowledge of under what conditions it is more advisable to burn the trash of cane fields than to plow it under.

PINEAPPLE SOILS.

Considerable time has been devoted to the study of certain soils where pineapples are grown. Within the last few years extensive plantings of pineapples have been made on a great variety of soil types, on red clays, clay loams, sandy loams, and sands. When the drainage, cultivation, and fertilization have been cared for the plantings have been successful on all the soil types except in certain sandy areas. On these sands the plants, in spite of good drainage, cultivation, and abundant fertilizing, fail to make a proper growth and present a peculiar bleached or chlorotic condition, quite distinct from the yellowing caused by lack of fertilizer or poor drainage. Investigations by the horticulturist and plant pathologist failed to reveal any fault in the cultivation or any bacterial or fungus disease. Hence it was apparent that the trouble was to be attributed to a soil condition and the problem was taken up by the chemical department.

The various pineapple plantations have been visited and samples of soil collected from all areas where the bleached pineapples occur and also from those lands where pineapples are growing well on soil of apparently the same general character. Some of the samples have already been analyzed and a clue obtained as to the probable cause of the trouble, but owing to the difficulties already mentioned the analytical work is not yet completed. To supplement the soil analyses, samples of the chlorotic plants and of adjacent green ones of the same age have been obtained to be analyzed for the ash constituents.

Soil and plants from two of the worst affected areas have been shipped to the station and are being used in pot experiments.

It does not appear that this trouble is likely to be very widespread as it seems to be confined to sands of a certain character such as do not occur to any great extent on the island. While the work is not yet completed, it appears that the trouble cannot be remedied by any special form of the fertilization or cultivation. It will probably be more profitable to abandon the plantings of pineapples where the bleaching has occurred and put in crops that are suited to the peculiarities of these soils.

PLANT NUTRITION.

The work in plant nutrition is directed chiefly to different phases of the action of lime and magnesia in plant growth.

The effect of an excessive amount of lime in producing chlorosis in certain plants is being studied in pot experiments. Field plats have been established with a high content of calcium carbonate where it will be possible to study the subject under more nearly natural conditions and on a larger scale. There is a great paucity of information concerning the action of excessive amounts of lime in producing chlorosis in plants.

The lime chlorosis of grapevines in Europe and recently the chlorosis of citrus trees in California are the only cases that have been studied to any extent. The high content of calcium carbonate in some Porto Rican soils makes it advisable to study this problem.

The theory that a certain ratio of available lime to magnesium is necessary for the best development of a plant is being studied. Besides the carbonates, the chlorids of calcium and magnesium are employed.

In testing the chlorids upland rice has been grown in sand and water cultures and has shown itself relatively resistant to them. While the chlorids of lime and magnesium are injurious to most plants there is one advantage in using them in that the question of the different degrees of availability of the two substances does not enter into the experiment.

It is necessary to run a large number of experiments on this subject as there are many variables that must be taken into consideration.

REPORT OF THE COFFEE EXPERT.

BY J. W. VAN LEENHOFF.

During the past year weather conditions at and in the vicinity of the substation for coffee at La Carmelita have again been unfavorable, and consequently positive results on various experiments, notably, those for the improvement of an old coffee plantation, cannot be shown. Severe hailstorms occurred in May, 1908, when the trees were loaded with small green berries of the first heavy blossoming and with large buds for the second heavy blossoming. Heavy rain and wind also destroyed a good quantity of blossoms. These storms followed by exceptional dry weather reduced the harvested crop to about one-half of the quantity expected from the heavy blossomings.

The size of the berries was extremely small, ranging from 350 to 400 berries per liter resulting in a small quantity of pounds of beans from a given quantity of berries. Many berries ripened when still the size of a pea and with only empty horns inside. The only exception was in the new plantings, yet as only slightly protected by shade trees. Here the damage seemed the slightest and the size of the berries was nearly normal.

To protect coffee against wind in the future, experiments have been begun with wind-breaks to surround the coffee on exposed places. For this purpose, emajagua (*Paritium tiliaceum*) and pavonia (*Hibiscus rosa-sinensis*) are to be used. Both grow quickly and luxuriantly in the mountain regions, they are very easy to propagate by cuttings and can probably also easily be kept pruned in hedge form. To fill up or close gaps in the wind-breaks the common Porto Rican bamboo is being tried, but it might be advisable to introduce for this purpose the more valuable thicker East Indian bamboos.

The new plantings of Porto Rican and foreign coffees are doing well, and of the latter some have given their first important crop. The quality, especially of the Java coffees, was very fine. Nearly the whole crop from the fine coffees has been prepared for seed which has been distributed free of charge to planters who desired them. The balance has been used for trials in the cup. Seeds of the following varieties were distributed: Padang, Preanger, Java (without name,) Ceylon hybrids, and Maragotype.

In some instances the station superintended the construction and planting of the seedbeds for these foreign coffees. It is to be regretted that the supply was not equal to the demand, and many growers, including some American planters, are in the waiting list for the next distribution. It is to be hoped that the plant-

ers will continue to interest themselves in these fine coffees and give their plantings good care so that eventually their products may be introduced into the United States market as homegrown Java and Mocha coffees. Of the latter probably some seed can be distributed next year.

Leaf weevils are still on the increase, and are doing much damage to the foliage and tender parts of the twigs. In several instances the young fruit was also attacked and even gnawed off especially on the young trees with little shade. These weevils are rapidly becoming a serious menace to the coffee plantations located in the higher altitudes. Among the many experiments undertaken for their control handpicking for the present is the most important. The weevils are nearly always found in pairs on or near the tender young leaves at the end of the twigs. A gentle touch is generally sufficient to make them drop. Women and children each furnished with a bottle provided with a common tin funnel in the opening of the neck go from tree to tree, hold the funnel under the leaves and cause the weevils to drop into the bottle.

Coffee leaf blight and borers in the shade trees continue on the increase. Coffee trees dying in patches of more or less size and without apparent causes are found in different localities.

IMPROVEMENT OF OLD COFFEE GROVE.

The experiments conducted on the renovation of an old coffee grove have been continued along the lines indicated in previous reports. From the $9\frac{1}{2}$ -acre tract 2,723 pounds of coffee were harvested and marketed, as compared with 2,472 pounds the year previous. Following the plan of determining the cost of production the total cost and selling prices are presented below.

COST OF PRODUCING 100 POUNDS OF COFFEE IN RENOVATION EXPERIMENTS.

Weeding, pruniug, etc.....	\$2.45
Gathering and preparing for market.....	2.73
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Total cost per 100 pounds, 1909.....	5.18
Average price obtained per 100 pounds.....	\$11.98

EXPERIMENTS WITH NEW PLANTING.

In 1903 experiments were begun to determine the cost of producing a coffee plantation. Reports have been made on the cost from year to year, and in 1908-9 a small crop of coffee (105 pounds per acre) was harvested from the new planting. During the past season hoeing between the rows could not be continued as formerly owing to the increased size of the trees, their extensive root systems, and the broken nature of the ground. The financial report is as follows:

EXPENSE PER ACRE FOR FIFTH YEAR OF NEW PLANTING.

Four weedings, at \$2.00 each.....	\$8.00
Pruning coffee and shade.....	2.00
Cost of gathering, preparing, and marketing crop..	2.73
	<hr/>
Total cost for fifth year.....	\$12.73
Crop for 1909, at \$11.98 per 100 pounds.....	12.58
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Net expense per acre for fifth year.....	0.15
Net expense per acre for four years previous	91.56
	<hr/>
Net expense per acre for five years.....	\$91.71

REPORT OF THE PLANT PATHOLOGIST.

BY G. L. FAWCETT.

The work mentioned in the last report has been continued, more attention being given to laboratory study because of better equipment. The study and experiments have included, however, the diseases of a large variety of plants. Diseases of citrus trees have claimed but little attention. Foot rot is bad in a few places with unfavorable soil conditions. The scab and melanose of the lemon occur, but are decidedly of minor importance. The fungus of witheritp is present in all the groves, but causes little or no injury except in the case of limes where it sometimes kills the flowering twigs. That withertip should be so much less destructive in Porto Rico than in some other citrus growing regions is probably due to favorable conditions presented on the island for the growth of these trees, the fungus finding its best foothold in trees suffering from an insufficient supply of water or mineral matter in the soil.

The mango is free from disease, except for the attacks of a fungus similar to that of withertip on citrus trees which causes a fruit spot on the superior thin skinned varieties, and what is of more moment, the falling of the blossoms and consequent loss of fruit. Trees flowering abundantly often set little fruit owing to this trouble. This is especially true if the time of flowering coincides with a period of heavy rains. This, as has been shown in Florida, may be prevented by spraying the tree in full flower with Bordeaux mixture. At this station the sprayed trees bore heavily, while the unsprayed ones yielded little or no fruit. Among other fruits with diseases requiring attention during the year were the custard apple, banana, and pineapple. In the case of the pineapple, experiments in soil disinfection with various chemicals for the prevention of root rot were carried out, the results of which are not yet apparent.

Cacao is affected with a pod rot, and much time and study has been given it. The loss caused by this disease is large, only a small percentage of the fruits that set reaching maturity. Experiments leading to its control are in progress. No other really destructive disease of this plant has been noticed.

The coffee of the island has several of the diseases common to this plant in the West Indies. The leaf blight (*Pellicularia koleroga*) is quite destructive during the wet season. It is much more difficult to control than would be supposed from its external occurrence and slow habit of growth. A leaf blight (*Stilbum flavidum*) is often present in very moist places, but occasions comparatively

little loss, as areas with conditions favoring its development are only to be found at elevations of 2,000 feet or more. Another and very destructive disease is characterized by the girdling of the tree at the crown. It is apparently due to a fungus which is invariably present in the area of rotten tissue at the base. Experiments for its control by means of soil disinfection and ditching are in progress.

The root disease of cane caused by the attacks of various organisms is quite prevalent, especially in poorly drained fields of old ratooned cane. Two of the fungi reported as prominent in causing this disease, (*Marasmius sacchari*) and the stellate crystal fungus, have been found. Up to this time the latter fungus has been noticed only on old leaf sheaths, never on freshly decayed roots. Its parasitism would appear doubtful were there no other evidence than as here observed. The rind disease is common, but as it is invariably found following the attacks of stalk borers and does not injure any plants except those already spoiled by these insects, it is hardly to be considered. For the pineapple disease which destroys the newly planted seed-cuttings, dipping of the seed cane in Bordeaux mixture is practised on some of the large plantations with results reported as successful. Experiments to control these diseases have been started and others will be undertaken during the coming year.

In addition to the work already mentioned the diseases of vegetables were studied during the early part of the year, and some work done on the fungus parasites of aphids and scale insects.

REPORT OF THE ASSISTANT ANIMAL HUSBANDMAN.

BY E. G. RITZMAN.

HORSES.

The past season the station purchased six American horses, five stallions and one mare, which, it is thought will be of value in improving the native stock. They arrived at the station during September and some of them had already moderately heavy coats. Notwithstanding this they did not seem to suffer from the warm climate, as they were clipped soon after arrival. They are now gradually becoming acclimated.

Two of the colts are Thoroughbreds, now about one year and eight months of age. One is by Stalwart out of Depends and the other by Prince of Melbourne out of Bell-of-Butte. Considerable interest is manifested in these two animals by the planters and it is expected that they will be in demand for breeding purposes. They possess strong bone with good size and have already shown fair speed for their age and condition. They will undoubtedly add materially to the size of the native stock and be of benefit in increasing the size of native coach horses, as the prepotency of Thoroughbred blood has been sufficiently demonstrated. The other three are saddlebred; one, now four years old, is by Rex McDonald and stands 16 hands. One, a yearling, is by Red McDonald; the third, a foal of about eight months is by Forest King. Both colts promise to develop into handsome and serviceable animals. The work of crossing with this type of blood on selected native stock is already beyond the experimental stage in many respects. They add considerably to size for weight carrying saddlers and for coaches. By establishing several stud depots, to be centrally located in breeding districts, they can be made available at a nominal fee, but mares brought for service should first be approved by a representative of the station in order to keep crossing within selected native stock only. The feeding presents no difficulty, although local markets offer only a limited variety of stock feed, as aside from corn no grain is grown on the island. At present a mixture of one part cotton seed meal, two parts shorts, and three parts of oats, is given them, three liters daily to the older horses and two liters to the younger. Molasses is also sometimes added in sufficient quantity to the ration. In addition to this they receive fresh cut grass.

Catarrh, which is prevalent at this season among native stock, has also affected the imported stock. Good results have apparently followed the inhalation of sulphur fumes, applied once a day for

short periods of time. Ticks have also attached themselves to some of the younger stock, though not in very great numbers except in one case. At this season of the year ticks are much more numerous than at any other time. They are apparently the same species of ticks that infest cattle.

CATTLE.

As the most economical method of improving stock naturally consists in crossing and grading up, the aim of the station has been to encourage this, both by example and advice. This is especially true where breeds are to be established under conditions differing radically from those under which they were produced. Some results of crossing with Shorthorn and Hereford blood are now being obtained at the station. These results, although not very extensive, indicate the prepotency of sires of those breeds in transmitting their characteristics on native stock. Crossing with improved dairy blood has not yet been attempted. Doubtless the introduction of dairy qualities would follow the use of good improved sires. It is suggested, however, that in making such an attempt for dairy purposes it would probably be safer to resort to a breed like the Guernsey, which, in many respects, resemble the native stock. During the past year four cross-bred yearling bulls of the Hissar breed from India were imported by the station. They are first crosses of the former breed on Shorthorn and Angus. They seem well adapted to this climate and do not harbor ticks as is the case with some of the improved breeds from the United States. They were introduced with a view to adding fresh blood and size to the working oxen. A previous introduction of such blood, about 60 years ago, had excellent results, some indications of which are still visible in the large working stock. Judging from the growth made by the animals recently imported it is believed that they will not disappoint expectation as to results. Although horses and mules are now displacing oxen for work on some of the larger cane plantations, yet the latter animal is more generally used on the roads for heavy drafting. Most of the inland roads would not permit the use of horses and 4-wheel wagons and on such roads oxen are at present indispensable. As the keep of oxen is also much lower than that of horses and mules it is not likely that a radical change from oxen to horses and mules will develop in advance of the conditions that make them profitable.

HOGS.

The work of the station with hogs during the past year has been principally to encourage improvement. Twelve boars and nine sows of the Berkshire breed have been sold at a nominal price for breeding purposes. They were distributed to different parts of the island where they form nuclei of improved blood. Some work has also been conducted in mineral nutrition, especially with reference to local conditions, but conclusions will not be

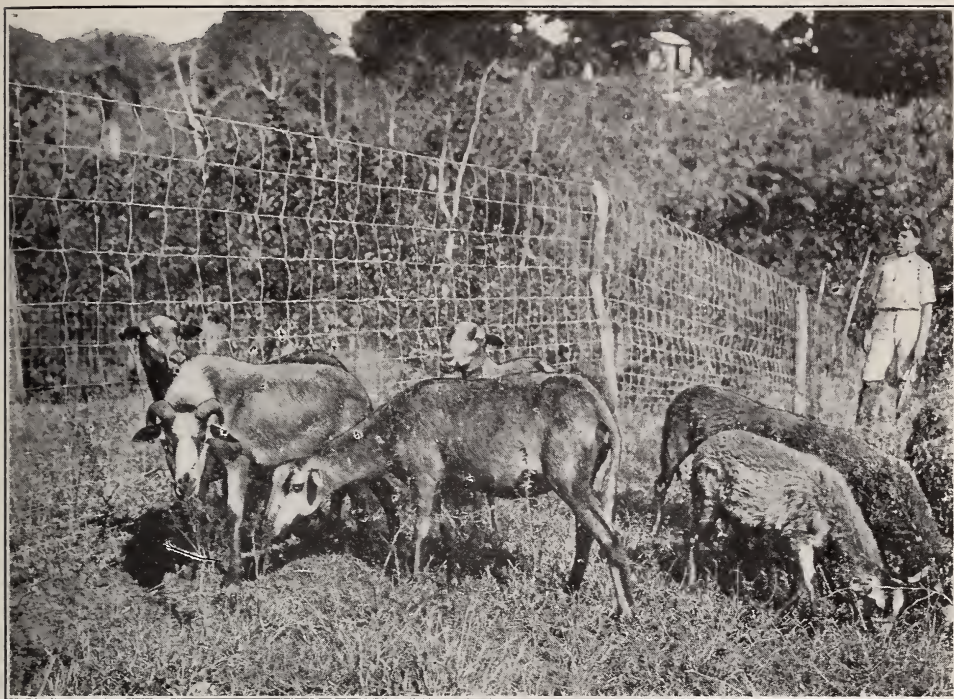


Fig. 1.—African woolless sheep.



Fig. 2.—New horse barn at Station.

published until more work has been done to corroborate the results in the first experiments.

Shorts remains the basis of feed used for hogs. It retails in the local market at about \$2.25 per cwt., which is very close to the average price of native corn in this locality, the latter selling for \$1.75 to \$2.00. However, the higher protein content of shorts makes it a more profitable feed than corn especially for growing stock, when the price is equal. The seed of the royal palm is much relished by hogs and makes a cheap feed where it is available. Digester tankage makes a cheap supplement to corn or cornmeal. The brand of tankage used at the station is guaranteed to contain 60 per cent protein and costs laid down at the station \$2.50 per cwt.

SHEEP.

The African woolless sheep introduced by the station during the previous year have increased from six to twenty head. They are gregarious in habit and exceedingly healthy in this climate. As mutton sheep they can stand material improvement. Their chief defect in this respect is a small leg of mutton and lack of covering on the loin. Their hardiness and suitability to this climate warrants every effort to improve the breed as a mutton producer. Good results would doubtless follow such an undertaking by careful selection, though a more rapid result would perhaps follow the use of a pure-bred mutton sire. An attempt has been made to cross these sheep with native stock to note the prepotency of type which would be of value in making an attempt with more improved blood. If good mutton or lamb could be produced for market, a demand which at present is not very strong would doubtless be created. This would increase the productiveness of the inland hills and give variety to the consumer of meat.

POULTRY.

All kinds of poultry seem to do well in this section of the island. Of the two extremes the nonsitters, however, are no doubt more suitable than the heavy meat breeds, though the intermediate type, like Plymouth Rock and Wyandottes, seem to do as well. The principal enemies to poultry are the mongoose and rat. The former not only eat the eggs but small chickens as well. Catarrh is also prevalent at certain seasons but at the station where stock has access to dry well-ventilated cover it has not become serious. During the year Plymouth Rock were added to the stock on hand, which at present consists of Leghorn and Plymouth Rock chickens, Toulouse geese, Mammoth Bronze turkeys and Pekin ducks. Some difficulty has been experienced in hatching and bringing up young poultry during the wet season. This trouble can no doubt be overcome if hatching or incubation is carried on from December to February, so that the young have a dry cool season to start. Suitable laying and chick feeds are rather scarce in local markets. The station has been purchasing its

supplies direct from dealers in the United States. They are not much more expensive than local feeds, of which corn is the chief factor, while on the other hand they are much more suitable for growing as well as laying stock. The above mentioned feeds can be laid down here at from \$2.50 to 3.77 per cwt., when bought in lots of 1,000 pounds, the price, of course, depending on the quality of feed desired. The mixture used at present at the station is made up of corn, oats, Kafir corn, millet, cracked wheat, sunflower seeds, oil cake, buckwheat, and charcoal; it is guaranteed to contain 10.50 per cent protein and costs laid down at the station \$2.76 per cwt. Beef scraps have also been used to good advantage when fed with corn. They cost laid down at the station \$3.04 per cwt. They are guaranteed to contain 50 per cent protein, which fed with corn, would make a good balance for laying hens.

Very much interest has been manifested in improved strains of chickens. During the past year the station sold 14 head of poultry, cockerels and pullets, for breeding purposes and in addition to this 142 settings of eggs (one dozen each) were sold for breeding purposes. At present the demand exceeds the supply, but the station will soon be able to meet the demand. With eggs retailing at from 25 to 50 cents a dozen the poultry industry should be made profitable on a limited scale.

ABATTOIRS AND REFRIGERATION.

The breeding of cattle and sheep for slaughter has its greatest drawback at present in the lack of proper methods for refrigeration and facilities for utilizing inferior parts of the carcass in the preparation of pickled meats, soups, meatloaf, and similar products, as is being done by packing houses. As there are no facilities for keeping such meat it must be sold within 24 hours after killing or become a waste. Owing to this fact the meat is consumed before it has properly ripened, which detracts from the flavor and texture that it should possess when cooked. Calves are not slaughtered to any great extent and mutton is also a comparatively rare product on the market. The result is the lack of variety which is now supplied in part by importations, especially of canned goods.

DAIRYING.

Lack of refrigeration also acts as a hindrance to dairying. In larger towns milk retails at 8 to 10 cents a quart and sometimes even higher. In small towns the milk is cheaper, owing to the absence of facilities or more often the impossibility of transporting it any great distance and thus equalizing supply and demand. This is not only depressing on what could be made a profitable industry in sections located some distance from large centers of population, but also makes such products a luxury to people living in cities. Butter is practically all imported, mostly in tins, and although it does not compare favorably with fresh creamery butter in the United States, yet it sells at 50 cents a pound. Three

classes of native cheese are made, the most common of which resembles cottage cheese. All of these cheeses are consumed comparatively fresh. The pressed cheese is said to keep two or three months, but could undoubtedly be kept longer under refrigeration. Owing to the high price of ice, refrigerators are not in common usage in private houses, which affects the trade in fresh dairy products. Sanitary improvement of dairy conditions is one of the most urgent needs of the island. At present all the milk consumed is boiled, which no doubt is a strong safeguard against disease, but deprives the consumer of the use of milk in its natural condition. The use of a calf in starting the milk to flow at milking time is unsanitary, but it appears that cows once broken in that way will not give the milk down without. This practice leaves the udder in a gummy condition to which filth adheres very readily. Furthermore, it is a wasteful practice and tends to decrease the yield. It is doubtful whether the use of good dairy sires would improve the yield of milk provided the prevailing methods of milking are adhered to, while on the other hand the yield could no doubt be increased by selection of young cows possessing good dairy characteristics and handled according to good dairy methods.

SILAGE.

In the summer of 1908 the station built a small silo with the object of testing the value of various fodder crops that are available in abundance during part of the year and also to find whether native stock would take to ensiled feed. This latter question is not without importance, as the opinion seems to prevail that native stock will eat none but green feed. At certain times here during the year feed becomes very scant on account of insufficient rain, while at other times it grows in abundance and as yet stock growers do not provide for periods of scarcity in times of plenty. The greatest waste, from a stock grower's point of view, is the destruction of cane tops, which are often burnt on the ground. The preservation of cane tops in such condition that native stock will eat them is therefore of great importance, since it means the saving of much feed otherwise wasted. Malojilla (Para grass) and native corn were also tried and in one of the tests some cowpeas were mixed with the grass. The silo at the station is built of brick with stone foundation and wire reinforcement. It is only 10 feet diameter by 20 feet height, inside measurement, and holds, therefore, about thirty tons of corn silage when full and well packed, but it is hardly of sufficient height to give good pressure.

In order to ensile malojilla successfully it is necessary to keep it well packed and weighted, as this material is very light and will not settle by its own weight sufficiently to keep the air out. One layer of malojilla which was immediately covered with about six feet of cut corn kept in splendid condition, almost as fresh as when cut. In ensiling malojilla it might be well to alternate every ten feet or so depth with some heavy crop, as cut corn. Results so far obtained seem to indicate that it should not be cut too

green and watery. Cane tops can also be kept well, especially when brought from the field rather fresh. When they are on the ground three or more days before ensiling the leaves become dry and are not cut readily. This prevents an even distribution of stalks and leaves and therefore also an even settling and fermentation. Cane leaves have a saw edge which is somewhat troublesome to stock. The saw edge is not destroyed by ensiling, but the leaves become so limp that it is less troublesome. When cut moderately short, in lengths of not more than one or two inches, it is still less troublesome. The corn ensiled at the station was cut when in the dough stage and kept very well. In the experiment the native as well as American stock ate all the silage fed but showed a decided preference for corn silage.

STOCK FEEDS.

The following table gives a list of the various feeds purchased by the station during the past year, also their cost, and composition. They are put in groups as follows: (1) Produced in Porto Rico, (2) available at local dealers, but shipped in, and (3) shipped to the station direct. The price covers cost of shipment in the last group.

COST AND NUTRITIVE VALUE OF SOME STOCK FEEDS.

NAME OF FEED.		DIGESTIBLE MATTER.		
GROUP I.	Cost at Mayaguez per 100 pounds.	Protein.	Carbo- hydrates.	Fat.
		Per cent.	Per cent.	Per cent.
Corn	\$1.75 to \$2.00 5 to 8 cents per gallon.	7.14	66.12	4.97
Molasses		2.5	70.00	
GROUP II.				
Oats	\$2.65	9.25	47.34	4.20
Cornmeal	2.25	6.25	65.26	3.50
Shorts	2.25	12.22	49.98	3.83
Rice, cracked	2.00	4.80	72.20	0.30
Cotton-seed meal	2.15	37.01	16.52	12.58
GROUP III.				
Cotton-seed meal	2.00	37.01	16.52	12.58
Digester tannage	2.56	60.00		8.00
Beef scraps	3.04	55.00		8.00
Poultry feed (containing some slaughter-house by-products)	3.77	50.00		
Poultry feed (containing mill refuse)	2.76	10.50		3.00
Chick feed (mostly cracked wheat)	3.05			
Bone feed	2.51	25.00		5.00

The original cost of these feeds as well as cost of shipment is much reduced when ordered in lots of not less than half a ton. Small lots of ready mixed mill feeds appear now and then on the market, but often they are of an inferior character, or too expensive for profitable use. Slaughterhouse by-products are not handled by local dealers and shorts is the only available mill feed to be had. Cornmeal and oats are the only stock feeds always available.

Milling and slaughterhouse by-products as well as cotton-seed meal and linseed meal would no doubt be handled by local dealers if the demand was sufficient to justify their importation. This lack of demand is due no doubt in part to ignorance regarding their value and methods of feeding. Venezuelan corn has been offered on local market at \$1.15 per cwt., but it is much inferior to the native grown product and the sample obtained by the station was full of weevils.

